MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU

AFWAL-TR-80-4106

LEVEL II

COMPUTER MANIPULATION OF LABORATORY DATA

George W. Fultz
Terry L. Green

University of Dayton Research Institute
Dayton, Ohio 45469

August 1980

TECHNICAL REPORT AFWAL-TR-80-4106

DTIC
ELECTE
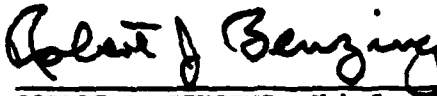JAN 0 7 1981

F

81 1 07 023

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This report has been reviewed by the Office of Public Affairs (ASD/PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.
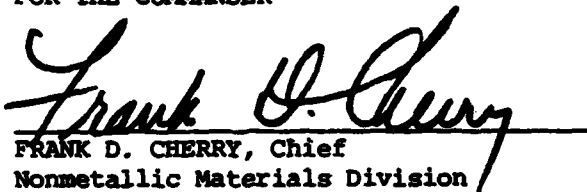
JOHN B. CHRISTIAN, Project Scientist   ROBERT J. BENZING, Chief
Fluids, Lubricants & Elastomers Branch   Fluids, Lubricants & Elastomers Branch
Nonmetallic Materials Division   Nonmetallic Materials Division

FOR THE COMMANDER

FRANK D. CHERRY, Chief
Nonmetallic Materials Division

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFWAL-TR-80-4106	2. GOVT ACCESSION NO. AD-A093 531	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) COMPUTER MANIPULATION OF LABORATORY DATA		5. TYPE OF REPORT & PERIOD COVERED May 1978 — May 1980
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) George W. Fultz Terry L. Green		8. CONTRACT OR GRANT NUMBER(s) F33615-78-C-5127
9. PERFORMING ORGANIZATION NAME AND ADDRESS University of Dayton Research Institute 300 College Park Avenue Dayton, Ohio 45469		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Project No. 2421
11. CONTROLLING OFFICE NAME AND ADDRESS Materials Laboratory (AFWAL/MLBT) Air Force Wright Aeronautical Laboratories, AFSC Wright-Patterson Air Force Base, Ohio 45433		12. REPORT DATE August 1980
		13. NUMBER OF PAGES 22
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Computer
Bearings
Torque

Plotting
Greases

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Programs have been written for the CDC 6600 computer in Extended Fortran. The data input for the programs is entered remotely using a CRT terminal. It is possible with the remote terminal to observe data before plotting. The data may then be edited and drawn into plots at a remote plotting site. Operational use has shown the CDC 6600 computer to be a valuable instrument and time saving device for the manipulation of large numbers of data points.

DD FORM 1473 EDITION OF 1 NOV 65 IS OBSOLETE

FOREWORD

This report was prepared by the University of Dayton Research Institute under Contract No. F33615-78-C-5127 and was initiated under Project No. 2421 entitled "Fluids, Fluid Containment, and Coating Materials for Aerospace Vehicles". It was administered under the direction of the Materials Laboratory, Air Force Wright Aeronautical Laboratories, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio with Mr. Robert Benzing as Project Monitor.

This report covers work conducted from May 1978 to May 1980.

Mr. George W. Fultz and Mr. Terry L. Green were the researchers and authors. The manuscript was released by the authors in May 1980 for publication as a technical report.

Accession For

NTIS GRA&I ☒
DTIC TAB ☐
Unannounced ☐
Justification

By
Distribution/

Availability Codes

Avail and/or
Dist Special

A

iii

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

SUMMARY

A computer analysis was obtained on R-4 bearing data which had been accumulated on several greases under numerous conditions. This was accomplished by writing two computer programs. The first program was used to extract the R-4 torque data from a master file, put the data in table form, and store the extracted data. The second program was written to take the extracted data and draw plots of that data.

Both programs were written in Extended Fortran on the CDC 6600 series computer. The data input for the programs were entered by using a CRT terminal. By using the CRT terminal, one was able to review the data extracted before plotting and, therefore, save valuable time when errors were found and corrected before plotting the data. The correct data was then fed into the second program which contained the necessary commands to draw plots of the data.

SECTION I
INTRODUCTION

During many types of laboratory testing, thousands of data points are generated and must be compared in order to select optimum materials for use in a given application. Since the computer is an instrument into which multiple random data points may be entered, stored, and retrieved, it was selected as the most desirable instrument for the manipulation of R-4 bearing data generated in the laboratory.

Manual reduction of this type of data is possible, however, it does not offer the flexibility to rapidly produce visual data plots and tables in a report form. The plots and tables are tailored to meet the requirements for the applications which may have generated that report. In addition, all of the graphs and tables now have a standard format, thus allowing easy comparison of data points from one report with the data points generated in previous reports. The data from previous reports may be included in new reports simply by calling the required data out of the computer.

While the creation of a curve in this manner may not appear to be justified due to the limited number of points on the curve, consider that among the data points which the computer indexed may have been five types of bearing, 15 greases, five test temperatures, seven levels of grease fill, starting torque, and running torque. This alone gives us 5250 data points to examine, and the computer program chooses only the data which is selected.

User oriented programs have been developed which allow the data to be digested after simple one-line entry, to ask questions of the user, and to give back only that data to the user in the quantity and format which the user has requested by giving proper response to the questions asked by the computer. The use of a cathode ray tube (CRT) terminal eliminates punch card errors, allows remote editing of the programs, can be backed remotely by punch cards and tape, and allows the user remote access to the computer from the laboratory.

1

This report discusses how the computer was used to generate report-ready graphs and tables for laboratory data.

SECTION II
DISCUSSION

1. EQUIPMENT

Manipulation of R-4 bearing data was accomplished by accessing a CDC 6600 series computer (References 1-3). Since it was inconvenient to physically travel to the computer site each time data was to be entered or extracted, access to the computer was made by using a remote CRT-terminal (Lear-Siegler Model ADM-31) (Reference 4). An Alanthus T-320 printer (Digital Equipment Corporation) (Reference 5) was attached to the terminal for in-lab printing of tables (see Figure 1). The CRT unit is connected to the computer by a standard telephone line using a modem (acoustic coupler). The telephone line is isolated to prevent outside interference during communication with the computer. This combination provides data exchange at the rate of 110 baud.

Data is relayed on a time sharing basis. Other users have access to the computer during our communications. Access to data files is limited by the use of a coded identification number and a separate password. Without using these codes, access to the information contained in these files is not possible, and information is not disclosed to others.

Plots or graphs are initiated on the remote terminal through the computer and are printed at a site which has an appropriate plotting device. This allows many users to utilize such a device in a cost-efficient manner. The computer also assigns priorities to the preparation of plots and will hold the data in memory until the time is appropriate to print the plots.

Programs used to initiate data manipulation are initiated by using SCOPE commands (References 1-2). The remote CRT terminal interrogates the computer by use of INTERCOM commands (Reference 3), and plots are printed by using a softward program called DISSPLA (Display Integrated Softward System and Plotting Language)(Reference 6). Software of this type may be considered part of the

3
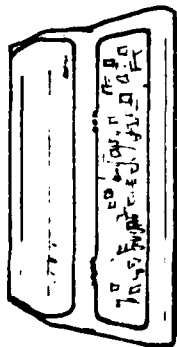
THE PRINTER
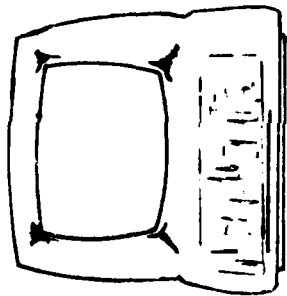
THE CATHODE RAY TERMINAL
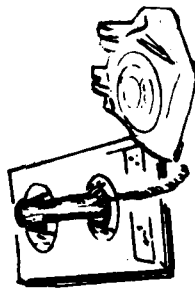
ACOUSTIC COUPLER

FIGURE 1

THE PERIPHERAL DEVICES

4

operational equipment and of equal importance to the operation of the computer as is the hardware (the physical parts of the computer).

2. OPERATION OF THE PROGRAMS

After assembling the necessary hardware (computer, CRT, printer, etc.) and software (SCOPE, INTERCOM, DISSPLA, etc.), it is necessary to generate programs by which manipulation of data may be accomplished.

The basic parameters desired were: (1) to be able to store data in quantity (INPUT), (2) to be able to extract data in a table form (OUTPUT #1), and (3) to extract data in a graphic form (OUTPUT #2).

Data was stored by using INTERCOM commands on the CRT. The computer is placed in the EDITOR mode, allowing the data to be entered in an orderly manner and to be changed at will. The CREATE command then allows a master file to be built as the data is entered. After the creation of the master file, new data may be added simply by using the add command (see Figure 2).

All of the data is entered into a file and may be saved and extracted in any order desired. For example, data for all bearings into which only 160 microliters of grease have been placed may be examined, or only data where the bearings have failed to start at -65°F, or only one grease at various temperatures in all types of bearings may be observed.

The program to extract data in table form is called GWFPLOT and is written in Extended Fortran. The program for the extraction of data for plotting is also written in Extended Fortran and is called FULTZ. FULTZ provides numbers for the software program (DISSPLA) which arranges the data points on the page, draws and labels the X and Y axes, and provides a mathematically smoothed curve. All of this is accomplished by answering questions which the computer is programmed to ask.
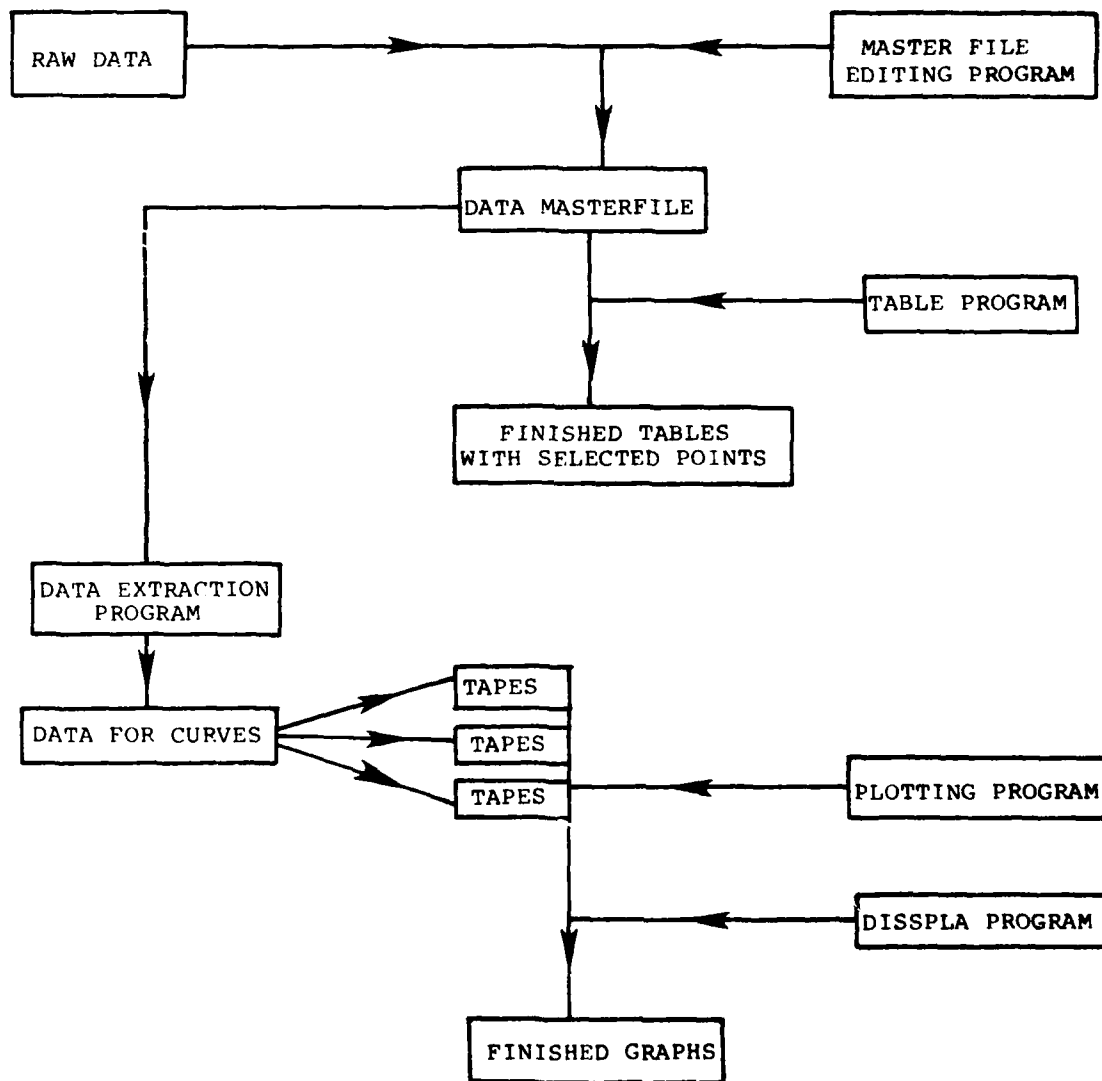
5

FIGURE 2

DATA FLOW CHART

6

SECTION III
EXPERIMENTAL

1. EXAMPLE OF A TYPICAL FILE LINE

A typical file line is arranged as follows:

100= MIL-G-83261 1602 POROUS 999.9 999.9 999.9 999.9 350 0123.4

Broken into segments, it would be read as follows:

100=   This is a line number assigned by the computer. Changes in the file are made by entering the command: 100= and then any new data desired may be entered. Old data is automatically replaced as the new is entered. The next line will be 110=, leaving blanks for additional data points if desired (i.e., 101,102,103).

MIL-G-83261   This identifies the grease sample on this line.

1602   This number represents the microfill (160 microliters) and a number coded to the appropriate bearing type (2 is a porous retainer bearing).

POROUS   This verbally identifies the bearing type.

999.9   The next four groups of numbers represent the torque data at different temperatures, the last of the four is the torque during life tests.

350   The temperature in degrees Fahrenheit at which life tests were run.

0123.4   The number of hours which the life test ran.

All files are typically entered in this manner but may be changed to accommodate the particular data being entered.

A step-by-step procedure for entering the data and creating a master file follows:

1. Turn on the CRT, printer, and modem.

2. Dial the phone number assigned to the computer.

7

3. When the computer answers, place the receiver in the modem cradle. A light will show when the computer is on-line.

4. The computer will ask for the discreet access number and password (ID/PW) and will need to know the terminal from which communication is being transmitted (TID).

5. If the computer has been provided with the correct access numbers, the process of attaching data to the files may begin.

6. Attach the appropriate file to the computer, i.e., ATTACH,FILE1.

7. Type: EDITOR. Now the file may be edited when the computer replies with two dots (..).

8. After editing the file the new data may be saved and recatalogued before returning it to the computer for storage.

2. PLOTTING A CURVE WITH DISSPLA

By answering the questions as the computer asks them, all parameters of the graph are defined including the data to be entered, the X and Y axes length, the letter size and spacing, and how the curve will be mathematically smoothed.

The operation is performed as follows:

```
COMMAND- ATTACH,DF,FULTZ
COMMAND- PURGE,START
 PFN IS
 START
COMMAND- EDITOR
..REQUEST,LGO,*PF
..DF
HOW MANY CURVES ON THIS PLOT? 3
TYPE PAGE SIZE X,Y(Y CAN NOT BE GREATER THAN 11 INCHES) 11,11
WHAT DO YOU WANT TO CALL CURVE 1? BEARING TYPE 1
WHAT DO YOU WANT TO CALL CURVE 2? BEARING TYPE 2
WHAT DO YOU WANT TO CALL CURVE 3? BEARING TYPE 3
WHAT IS NAME OF X-AXIS?   FAHRENHEIT
WHAT IS NAME OF Y-AXIS?   GM-CENTIMETER
```

```
WHAT IS LENGTH OF X-AXIS?   6
WHAT IS LENGTH OF Y-AXIS?   6
HOW MANY LINES IN TITLE(20 CHAR PER LINE)?   3
ENTER FIRST LINE   GREASE A
ENTER SECOND LINE  STARTING TORQUES
ENTER THIRD LINE   BEARING TYPE 1
IF GRAPH, TYPE1      IF LOG,TYPE2      IF XLOG,TYPE3     IF YLOG,TYPE4   1
ENTER---XMIN,XDEL,YMIN,YDEL~100,80,-16,16
IF YOU WANT DOUBLE Y-AXIS TYPE1       1
WHAT IS XPOS AND YPOS?      -.8,0

WHAT IS NEW Y-AXIS NAME?    OUNCE-INCHES
IF YOU WANT DOUBLE X-AXIS   TYPE1      1
WHAT IS XPOS AND YPOS?   0,-.8
WHAT IS NEW X-AXIS NAME?    CENTIGRADE
IF GRID IS WANTED TYPE1, IF NOT TYPE 2.    2
IF NO POLYNOMIAL EXTRAPOLATION IS WANTED TYPE1     2
FOR THE PROPER POLYNOMIAL ENTER SPLINE,POLY3,OR POLY5     SPLINE
PLOT 1      LINE= 0     PTS= -1    PTS&LNE= 1     1
PLOT 1      DOT= 1      DASH= 2    CHNDOT= 3     CHNDSH= 4 SOLID= 5      1
PLOT 2      LINE= 0     PTS= -1    PTS&LNE= 1     1
PLOT 2      DOT= 1      DASH= 2    CHNDOT= 3     CHNDSH= 4 SOLID= 5      2
PLOT 3      LINE= 0     PTS= -1    PTS&LNE= 1     1
PLOT 3      DOT= 1      DASH= 2    CHNDOT= 3     CHNDSH= 4 SOLID= 5      3
ENTER INCHES TO THE RIGHT AND INCHES TO THE TOP OF THE PHYSICAL
 ORIGIN OF THE PLOT. 6,4.5
      END GWF
        .286 CP SECONDS EXECUTION TIME
..REWIND,TAPE1

..FTN,I=TAPE1,L=0

        .316 CP SECONDS COMPILATION TIME
..CATALOG,LGO,START,CY=2
 NEWCYCLE CATALOG
 RP = 008 DAYS
 CT ID=A123456 PFN=START
 CT CY= 002   00000576 WORDS.:
..ATTACH,DATA,CY=1
 PFN IS
 DATA
..REQUEST,DD,*Q
..E,DATA,S
..D,180,200
../RUN./=/START,CY=2./,A
        1 CHANGE(S)
```

```
100=ABCDE,T120,CM123456,FGHIJ. A123456,FULTZ,78901
110=COMMENT.****************************
120=COMMENT. *   THIS IS A BATCH JOB   *
130=COMMENT. *        NO    CARDS      *
140=COMMENT. ****************************
150=ATTACH,TAPE1,CY=2.
160=ATTACH,TAPE2,CY=2.
170=ATTACH,TAPE3,CY=2.
210=ATTACH,DFT,START,CY=2.
220=ATTACH,PP,DISSPLA,ID=LOCATION,SN=XYZ,CY=1.
230=LIBRARY,PP.
240=RFL,123456.
250=DFT.
260=ONLINE.
..SAVE,DD,N,O,A
..BATCH,DD,INPUT,AC
..BYE,BYE
COMMAND- LOGOUT
```

Figure 3 illustrates bearing torque data utilizing both metric and English scales. Notice that torque data is displayed in both gram-centimeters and ounce-inches, and temperatures are given in both degrees Centigrade and degrees Fahrenheit.

Should a grid be desired, the computer may be asked to print a grid and the resultant curve will appear with a grid as shown in Figure 4. This illustration also shows the data plotted using a single scale.

As shown in Figure 5 many different greases may be examined on the same plot.

Figure 6 illustrates a different type of data since we are now looking at the life of a bearing ra ther than its running or starting torque.
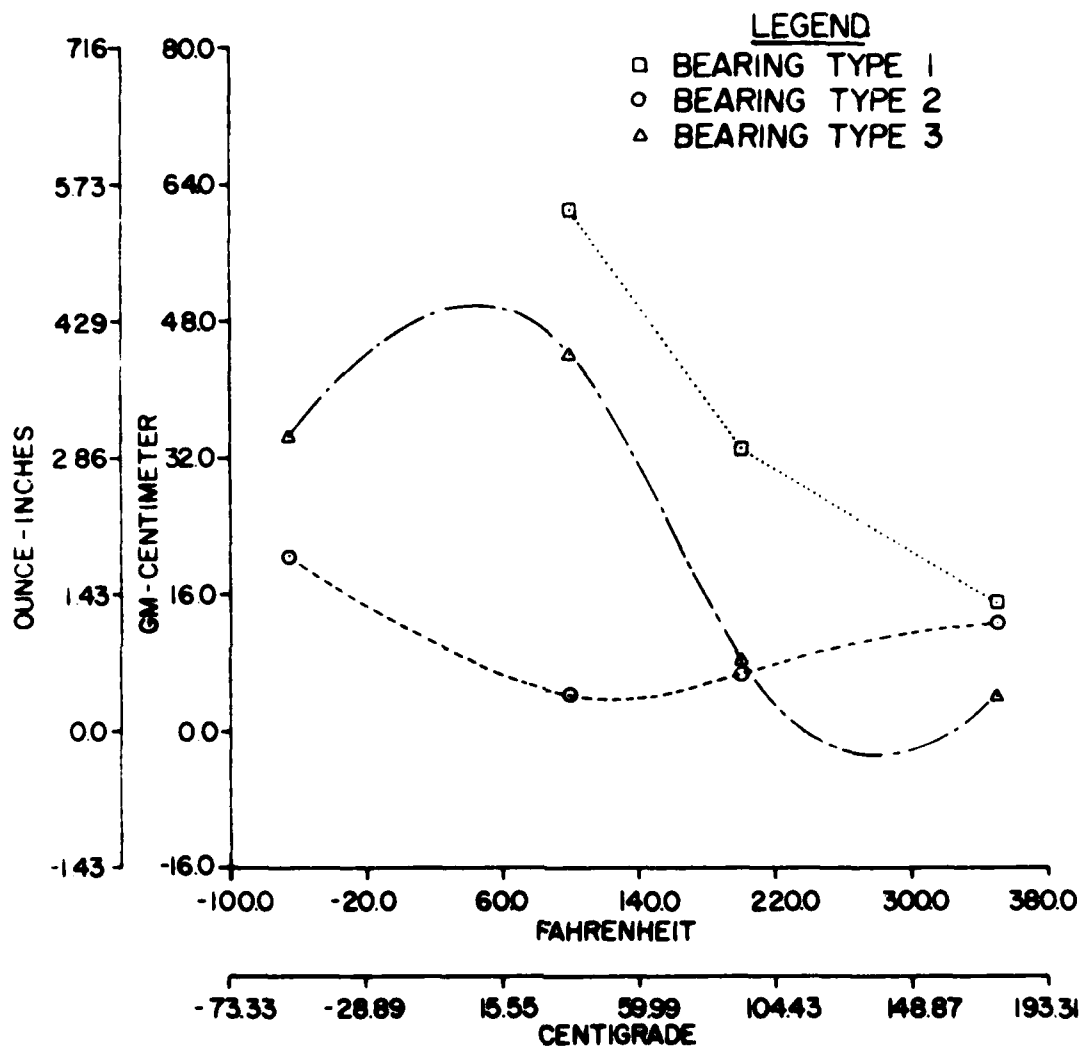
FIGURE 3
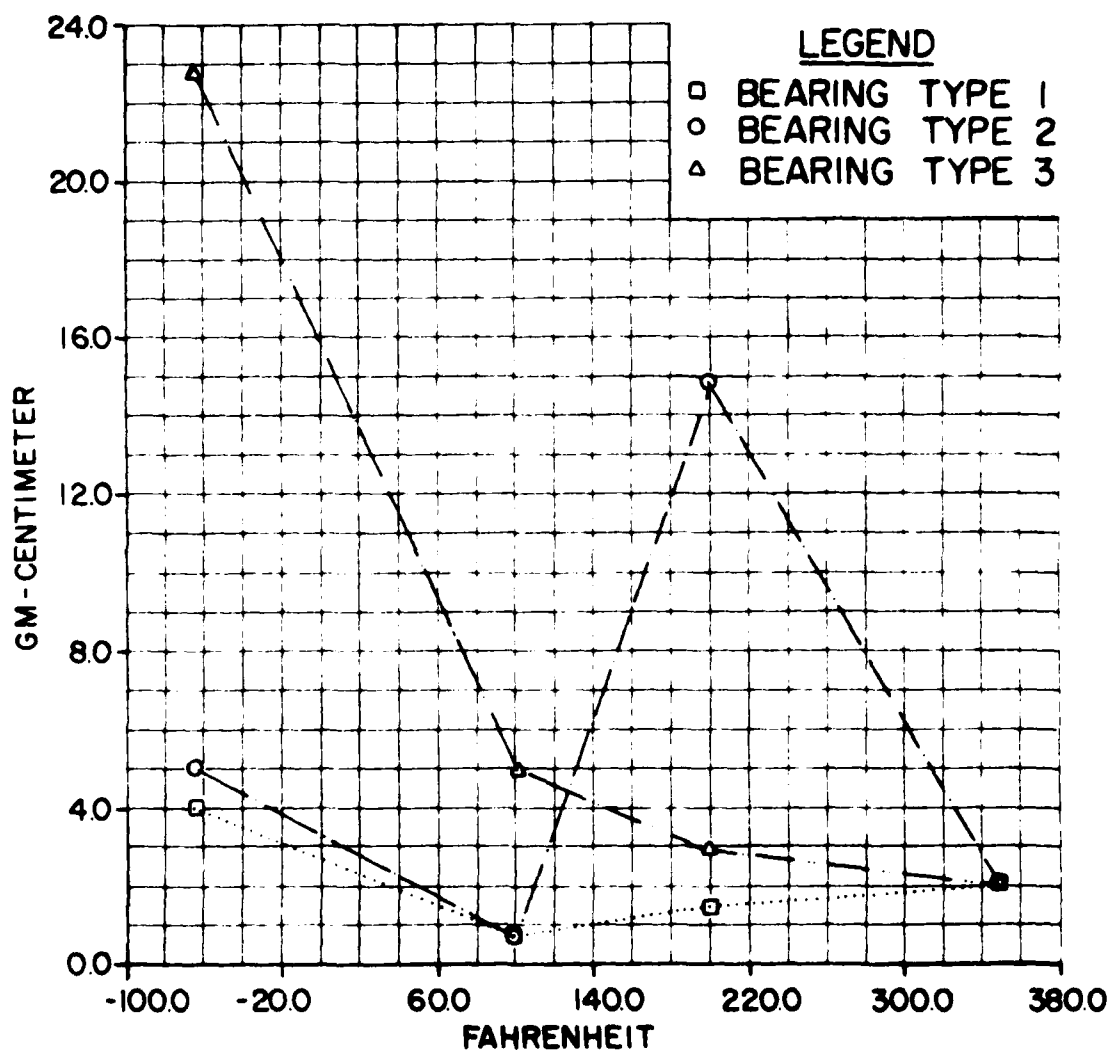BEARING TORQUES WITH METRIC AND ENGLISH SCALE
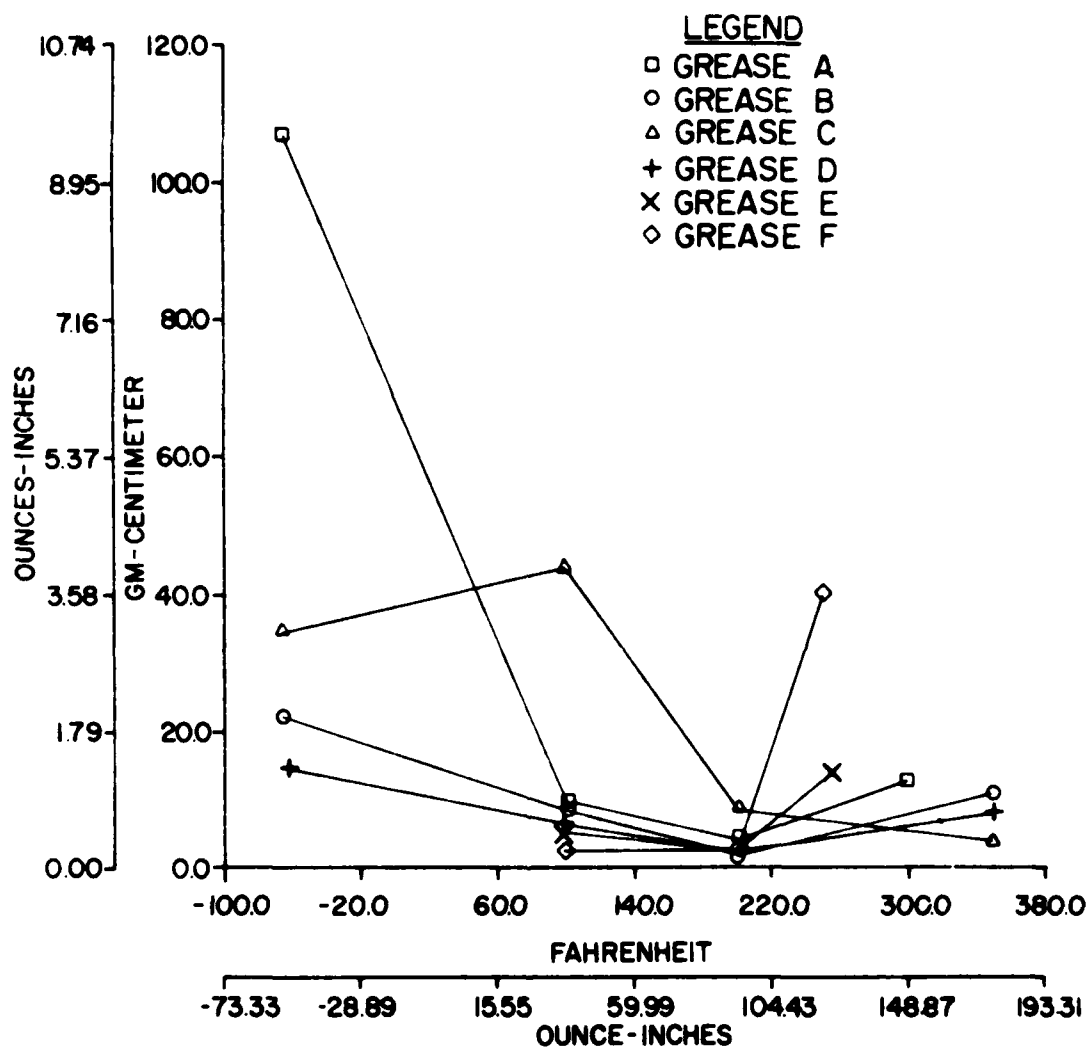
11

FIGURE 4
BEARING TORQUES WITH GRID, SINGLE SCALE

12

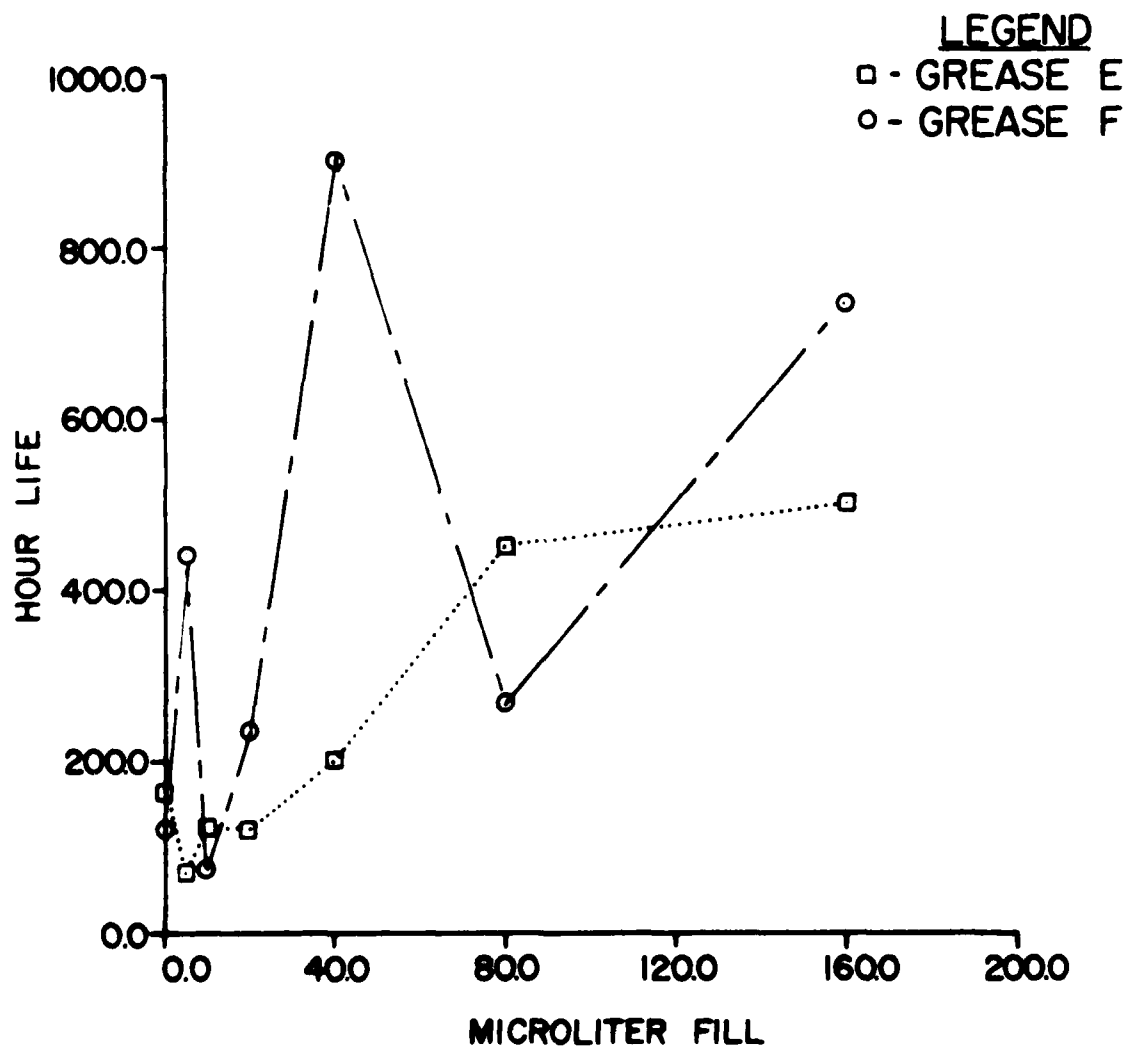FIGURE 5
BEARING TORQUES, MULTIPLE GREASES

FIGURE 6
BEARING LIFE

14

SECTION IV
CONCLUSIONS

Report-ready tables and graphs are generated as desired from a large number of data points. This time-saving feature substantially reduces errors from input while allowing the user to preview entries prior to generating completed plots (Reference 7).

Rapid comparisons between multiple parameters allows selection of optimum grease and bearing combinations for any given application, while saving dollars and energy. It also reduces the workload on laboratory personnel during the data reduction phase, thus allowing more time to be spent on research.

The system is, however, of little or no value when used with only small amounts of data.

It is also advisable to copy all programs and data files on punchcards and tapes to preclude loss of these files in the event of a computer malfunction.

The computer is a useful instrument for the laboratory scientist who wishes to reduce a large number of data points into report-ready graphs and tables in a minimum amount of time.

REFERENCES

1. Control Data Corporation, SCOPE reference manual - 6000 version 3.3 (1970).

2. Control Data Corporation, education series C6003 (SCOPE).

3. Control Data Corporation, INTERCOM reference manual - 6000 version 4 (1975).

4. Lear Siegler, Inc., ADM-31 Data Display Terminal Operators Manual, DP-111 (April 1979).

5. Digital Equipment Corporation, LA 34 Users Guide, EK-OLA34-U6-001 (November 1978).

6. Integrated Software Systems Corporation, DISSPLA Beginners/ Intermediate Manual (October 1973).

7. J. B. Christian, "Lubricant Variables Influencing Miniature Bearing Torque," AFML-TR-76-135 (July 1976).